



ARIZONA DEPARTMENT OF TRANSPORTATION

REPORT NUMBER: FHWA-AZ-8802 & FHWA-AZ-8803

SENTER AND TREND ATTENUATOR FIELD INSTALLATIONS

Construction Report

Prepared by:

Douglas J. Lattin
Arizona Transportation Research Center
College of Engineering & Applied Sciences
Arizona State University
Tempe, Arizona 85287

February 1990

Prepared for:

Arizona Department of Transportation
206 South 17th Avenue
Phoenix, Arizona 85007
in cooperation with
U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Arizona Department of Transportation or the Federal Highways Administration. This report does not constitute a standard, specification, or regulation. Trade or manufacturer's names which may appear herein are cited only because they are considered essential to the objectives of the report. The U.S. Government and the State of Arizona do not endorse products or manufacturers.

Technical Report Documentation Page

1. Report No. FHWA-AZ-8802/8803	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle SENTER AND TREND ATTENUATOR FIELD INSTALLATIONS		5. Report Date FEBRUARY 1990	
		6. Performing Organization Code	
7. Author (s) DOUGLAS J. LATTIN		8. Performing Organization Report No.	
9. Performing Organization Name and Address ARIZONA TRANSPORTATION RESEARCH CENTER ASU COLLEGE OF ENGINEERING - ERC 405 TEMPE, ARIZONA 85287		10. Work Unit No.	
		11. Contract or Grant No. HPR-PL-1(37) ITEM 114	
12. Sponsoring Agency Name and Address ARIZONA DEPARTMENT OF TRANSPORTATION 206 SOUTH 17TH AVENUE PHOENIX, ARIZONA 85007		13. Type of Report & Period Covered CONSTRUCTION REPORT	
		14. Sponsoring Agency Code	
15. Supplementary Notes Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration			
16. Abstract Arizona's canal network is extensive and necessitates the existence of many short bridges on the highway network. The necessity for maintaining access to adjacent canal roads dictates that any barrier installation intended to shield errant vehicles from the bridge rail hazard must fit within the limited space between the bridge end and the canal road. The available space for such an installation is often less than 35 feet. Energy Absorption Systems, Inc. (EASI) has developed two similar attenuating end terminals, the SENTRE system and the TREND system, for use in such limited space applications. EASI has demonstrated that both their TREND and SENTRE systems meet the dynamic performance requirements set forth in NCHRP-230. The conclusion that these systems conform to dynamic performance specifications is based on full scale crash testing. The length of time, however, that these devices have been formally monitored on highways is not sufficient for validating the adequacy of in-service performance. The objective of this research effort is to evaluate the in-service performance of the TREND and SENTRE attenuator systems when installed on appropriate ADOT projects. Two construction projects, both involving canal bridge rail modification, were selected for test installations. This research effort embraces two separate experimental projects, and hence two experimental project numbers. The SENTRE system was installed and reported to the FHWA as Experimental Project Number AZ-8802 and the TREND system was installed and reported to the FHWA as Experimental Project Number AZ-8803. At the time that the TREND and SENTRE projects were constructed, both systems were classified as Experimental by the FHWA. Although the SENTRE attenuator has since been upgraded to Operational status, both installations will continue to be evaluated for the full two year evaluation period specified in the original workplan. Upon completion of the evaluation period a Final Report will be prepared which contains all in service performance data.			
17. Key Words ATTENUATOR, GUARDRAIL, SAFETY, ROADSIDE BARRIER, LONGITUDINAL TRAFFIC BARRIER, BCT, TREND, SENTRE, TRANSITION SECTION, END TERMINAL	18. Distribution Statement Document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia, 22161	23. Registrant's Seal 	
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 61	22. Price

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS					
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol	
LENGTH					LENGTH					
in	inches	25.4	millimetres	mm	mm	millimetres	0.039	inches	in	
ft	feet	0.305	metres	m	m	metres	3.28	feet	ft	
yd	yards	0.914	metres	m	m	metres	1.09	yards	yd	
mi	miles	1.61	kilometres	km	km	kilometres	0.621	miles	mi	
AREA					AREA					
in ²	square inches	645.2	millimetres squared	mm ²	mm ²	millimetres squared	0.0016	square inches	in ²	
ft ²	square feet	0.093	metres squared	m ²	m ²	metres squared	10.764	square feet	ft ²	
yd ²	square yards	0.836	metres squared	m ²	ha	hectares	2.47	acres	ac	
ac	acres	0.405	hectares	ha	km ²	kilometres squared	0.386	square miles	mi ²	
mi ²	square miles	2.59	kilometres squared	km ²						
VOLUME					VOLUME					
fl oz	fluid ounces	29.57	millilitres	mL	mL	millilitres	0.034	fluid ounces	fl oz	
gal	gallons	3.785	litres	L	L	litres	0.264	gallons	gal	
ft ³	cubic feet	0.028	metres cubed	m ³	m ³	metres cubed	35.315	cubic feet	ft ³	
yd ³	cubic yards	0.765	metres cubed	m ³	m ³	metres cubed	1.308	cubic yards	yd ³	
MASS					MASS					
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz	
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb	
T	short tons (2000 lb)	0.907	megagrams	Mg	Mg	megagrams	1.102	short tons (2000 lb)	T	
TEMPERATURE (exact)					TEMPERATURE (exact)					
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C	°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F	
TEMPERATURE (approximate)					TEMPERATURE (approximate)					

* SI is the symbol for the International System of Measurement

(Revised April 1989)

TABLE OF CONTENTS

INTRODUCTION.....	1
Background.....	1
Roadside Barrier Elements.....	1
Roadside Barrier Service Requirements.....	1
Barrier Classification.....	1
Problem Statement	2
ADOT Standard End Treatments.....	2
Limited Space Available for Barrier System.....	3
Alternate End Treatment.....	3
FHWA Approved on Experimental Basis	6
Objectives.....	6
Field Installation	6
In-Service Evaluation	6
PROJECT LOCATION AND DESCRIPTION.....	6
AZ-8802: SENTRE Attenuator Field Installation.....	6
Accident History.....	7
AZ-8803: TREND Attenuator Field Installation.....	8
Accident History.....	8
CONSTRUCTION PLANS	8
MATERIALS TESTING.....	8
DESIGN.....	8
Requirements.....	8
Barrier Design	9
CONSTRUCTION	9
General Activity Description	9
Traffic Control.....	9
Concrete Footings	9
SENTRE Transition Segment.....	10
Base Plates.....	10
Panel Support Posts	10
Thrie Beam Panels and Sand Containers	13
SENTRE Splice to Transition Segment.....	13
TREND Splice to Concrete Parapet Wall	14
Redirecting Cable.....	15
Completed Systems.....	15
Economics.....	17
Construction Costs - Alternates vs. SENTRE and TREND.....	17
Cost Analysis.....	17
PRELIMINARY EVALUATION.....	18
Concerns and Potential Problems.....	18
Conclusions.....	19
REFERENCES	20

TABLE OF CONTENTS (continued)

APPENDIX A - CURRENT ADOT STANDARD DETAILS	A1
APPENDIX B - EASI TECHNICAL DISCUSSION	B1
APPENDIX C - FHWA APPROVED WORKPLAN.....	C1
APPENDIX D - CONSTRUCTION PLANS FOR AZ-8802 (SENTRE)	D1
APPENDIX E - CONSTRUCTION PLANS FOR AZ-8803 (TREND).....	E1

LIST OF FIGURES

Figure 1 Breakaway Cable Terminal (BCT).....	2
Figure 2 Standard Attenuator Assembly	2
Figure 3 Canal Road Access to be Maintained.....	4
Figure 4 Full LON Segment is Provided.....	4
Figure 5 The SENTRE Attenuator System	5
Figure 6 The TREND Attenuator System.....	5
Figure 7 AZ-8802 - SENTRE Attenuator Installation Site.....	7
Figure 8 AZ-8803 - TREND Attenuator Installation Site.....	7
Figure 9 SENTRE Concrete Footing	10
Figure 10 SENTRE Transition Segment.....	10
Figure 11 Drilling Bolt Hole.....	11
Figure 12 Pouring Epoxy into Bolt Hole.....	12
Figure 13 Base Plate Hardware.....	12
Figure 14 Hole at Bottom of Post 1	12
Figure 15 Mushroom Bolt Assembly	13
Figure 16 Sand Container Configuration	13
Figure 17 Special Downstream Splice	14
Figure 18 Proper Upstream Splice	14
Figure 19 Bracket Attaching TREND to Front of Concrete Parapet Wall	15
Figure 20 Attachment of TREND Backstrap to Back of Concrete Parapet Wall	15
Figure 21 Front Anchor of Redirection Cable	16
Figure 22 Rear Anchor of Redirection Cable	16
Figure 23 Completed SENTRE	16
Figure 24 Completed TREND	17
Figure 25 Panel Lap is a Concern on Departure Side.....	19